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Full Title:

**Qualitative Behaviour Assessment of dogs in the shelter and home environment and
relationship with quantitative behaviour assessment and physiological responses.**

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27 **Abstract**

28 Qualitative Behaviour Assessment (QBA) was utilised to examine the behavioural
29 expression of dogs in different housing environments and the results were compared to
30 measurements of quantitative behaviour and physiology. Firstly, quantitative behavioural
31 and physiological differences were investigated between dogs in 3 housing environments
32 (short-term shelter confinement, ≤ 4 days, $n = 10$; long-term shelter confinement, > 30
33 days, $n = 9$; and domestic living situations, $n = 10$). Each dog's behaviour was recorded
34 over a 4 h period using an ethogram consisting of 21 behaviour categories. Dogs in both
35 short (SD) and long (LD) term confinement displayed higher frequencies of paw-lifting
36 ($P < 0.001$), displacement behaviour (digging and/or drinking $P < 0.01$), vocalisation ($P <$
37 0.05) and locomotory activity ($P < 0.001$) compared to dogs maintained as family pets
38 (PD). Salivary cortisol concentrations did not differ amongst groups ($H = 0.55$, $P = 0.76$).
39 Secondly, quantitative behaviour and QBA were combined to investigate differences
40 among these same 29 dogs when filmed for 1 min in both their Home Environment and a
41 standardised Novel Environment. QBA of these video clips was made by 10 observers
42 utilising Free-Choice-Profiling methodology. Generalised Procrustes Analysis was used
43 to calculate a consensus profile and three main dimensions of dog expression in both
44 Environments. The observers repeated dog scores on these dimensions with high
45 accuracy ($P < 0.001$). Observers perceived dogs as more 'relaxed/content' in the Home
46 Environment ($H = 17.86$, $P < 0.0001$), and more 'calm/relaxed' in the Novel
47 Environment ($H = 13.58$, $P < 0.001$), than SD and LD dogs. In the Novel Environment,
48 LD dogs were perceived as more 'inquisitive/curious' ($H = 5.97$, $P < 0.05$), and SD dogs
49 as more 'curious/cautious' ($H = 6.82$, $P < 0.05$), than the other groups. Quantitative
50 assessment of the 1 min Home and Novel Environment video clips were analysed using
51 Principle Component Analysis (PCA), generating two main factors explaining 88% and
52 76% of the variation respectively. PCA factor 1 ('rest') and QBA Dimension 1
53 ('relaxed/content') correlated ($P < 0.0001$) in the Home Environment'. In the Novel
54 Environment PCA factor 1 ('stand', 'sniff') correlated with QBA Dimension 1
55 ('clam/relaxed') and PCA factor 2 ('sniff', 'walk') correlated with QBA Dimension 2

56 ('curious/inquisitive'). There was no correlation between QBA dimensions and cortisol
57 concentrations. In sum, these results indicate that a combined quantitative/qualitative
58 assessment facilitates the interpretation of behavioural variances resulting from housing
59 differences and supports utilising QBA for the assessment of dog behavioural expression.

60

61 **Keywords:** *Behavioural Expression; Canis familiaris; Dog; Saliva Cortisol; Qualitative*
62 *Behavioural Assessment; Shelter.*

63

64

65 **1. Introduction**

66

67 The aim of shelters is to rehome animals and in doing so optimise their long term welfare
68 (Titulaer et al., 2013), yet the shelter environment itself has been shown to be inherently
69 stressful (Wells, 2004, Ronney et al., 2007 and Bowman et al., 2015). Upon entry
70 individual dogs are exposed to a number of stressors including; isolation in a novel
71 environment (e.g. Beerda et al., 1999), separation from social attachment figures (e.g.
72 Tuber et al., 1996), exposure to excessive noise levels (e.g. Sales et al., 1997 and
73 Bowman et al., 2015), changes in routine and introduction to an unpredictable
74 environment (e.g. Tuber et al., 1999). Numerous authors have reported that exposure to
75 these stressors, both short and long term, leads to compromised welfare (Beerda et al.,
76 2000, Hennessy et al., 2002, Stephen and Ledger, 2006, Taylor et al., 2007).

77

78 Studies investigating the compromise to dog welfare, during their stay in shelters, have
79 utilised behavioural and physiological measures of stress (e.g. Hennessy et al., 2001,
80 Barrera et al., 2010 and Bergamasco et al., 2010). More recently cognitive measures of
81 emotional valence and qualitative assessment of emotional experience have been used to
82 assess the impact of shelter stressors; including conspecific separation (Walker et al.,
83 2014), short vs long term shelter housing (Titulaer et al., 2013), and the assessment of
84 individual Quality of Life (QoL) (Kiddie and Collins, 2014 and Kiddie and Collins,
85 2015).

86

87 Quantitative measurement of behaviour indicative of stress in the kennel environment is
88 time consuming and its interpretation tends to rely on extensive post-hoc analysis
89 (Stephen and Ledger, 2006; Rooney et al., 2007 and Haverbeke et al., 2008). Emphasis is
90 usually on individual behaviour that occurs most frequently or for longer durations, and
91 the value of infrequent behaviour, that potentially indicates stress, can be lost in statistical
92 analysis (e.g. circling, lip-licking or paw lifting [Rooney et al., 2009]). The behavioural
93 repertoire of dogs is diverse, and the variability of individual response patterns is

reinforced by the extreme morphological variation seen within this species, and by individuals' age, sex and past experience. All these factors can make it difficult to interpret observed shifts in behaviour in relation to stress, and can give rise to studies reporting apparently inconsistent or contradictory results. Unsurprisingly, there has been little consensus on which behaviour may be indicative of poor, or good, welfare in dogs (Hiby et al., 2006) with recent research evidencing the complicated nature of repetitive behaviour in kennelled dogs (Denham et al., 2014).

101

HPA activity is a well utilised method for the assessment of a dog's physiological response to the shelter environment (for a review see Hennessy, 2013). HPA activity has traditionally been measured through plasma cortisol (e.g. Hennessy et al., 1997, Beerda et al., 1998 and Hennessy et al., 1998), and more recently, urine cortisol:creatinine ratios (C/Cr) (e.g. Hiby et al., 2006; Stephen and Ledger, 2006 and Rooney et al., 2007). The analysis of salivary cortisol has also become an increasing popular non-invasive alternative to plasma analysis in the assessment of canine stress (e.g. Coppola et al., 2006, Horváth et al., 2007, Bergamasco et al., 2010 and Bowman et al., 2015). Cortisol, however, is produced in response to all sustained arousal, not only that produced by stress (Hiby et al., 2006 and Belpedio, 2010), and therefore cortisol measurement must be considered alongside other ways of assessing shelter stressors.

113

Qualitative assessment approaches have been engaged to evaluate general Quality of Life (QoL) in dogs (e.g. Hewson et al., 2007, Taylor and Mills, 2007 and Timmins et al., 2007). Recently this approach has been utilised to specifically assess the QoL of dogs in shelters (Kiddie and Collins, 2014 and Kiddie and Collins, 2015). Kiddie and Collins (2014 and 2015) employed a questionnaire developed for use by shelter staff who act as proxies for dogs, which are unable to speak for themselves. However, such studies are limited by their reliance on the judgments of people who know the dog subjects well, such as their owners or trainers.

122

123 An alternative methodology that might provide a more subjective tool in the qualitative
124 assessment of a dog's experience in a shelter environment is Qualitative Behaviour
125 Assessment (QBA). QBA is based on human descriptors that summarise the dynamic,
126 expressive style of an animal's interaction with its environment e.g. 'confident', 'anxious'
127 or 'apathetic', and was originally developed and validated for pigs (Wemelsfelder et al.,
128 2001, Wemelsfelder et al., 2009 and Wemelsfelder et al., 2012). QBA has since been
129 applied to a range of animals including dairy cattle, horses, dairy buffalo, sheep, and dogs
130 (e.g. Rousing and Wemelsfelder, 2006, Napolitano et al., 2008, Walker et al., 2010,
131 Cockram et al., 2012 and Napolitano et al., 2012). Walker et al. (2010) showed that
132 observers unacquainted with dog subjects could coherently and consistently assess these
133 dogs' emotional expressions from brief video clips. Additionally, QBA has been
134 documented to show significant and meaningful correlations with physiological indices of
135 stress in a range of species including; pigs, cattle and sheep (Stockman et al., 2011,
136 Rutherford et al., 2012, Wickham et al., 2012 and Stockman et al., 2013).

137

138 The present study investigates the applicability of utilising QBA within the shelter
139 environment by exploring whether and how QBA can be combined with quantitative
140 behavioural and physiological indicators to investigate the effect of lengths of shelter stay
141 on dogs.

142

143 **2. Materials and methods**

144

145 Procedures were approved by The University of Auckland Animal Ethics Committee
146 (ethics approval number R585).

147

148 *2.1 Study animals*

149 Twenty nine dogs were used in this study (three entire females, 14 de-sexed females, six
150 entire males and six de-sexed males). Of these, nine dogs were housed in long term (LD)
151 confinement (≥ 30 days in an animal shelter), 10 dogs were housed in short term (SD)

152 confinement (≤ 4 days in an animal shelter), and 10 pet dogs (PD) had lived in their
153 owners' homes for a minimum of 12 months prior to the commencement of the study.
154 Recently researchers have been increasingly utilising companion dogs to provide base
155 line results when assessing the effects of the shelter environment (Beerda et al., 1999,
156 Hennessey et al., 1997, Steiss et al., 2007 and Viggiano et al., 2009). In this study our PD
157 group acted as a control. The LD and SD dogs were sourced from two animal shelters
158 (Shelter A $n = 4$ [LD], $n = 2$ [SD]; Shelter B $n = 5$ [LD], $n = 8$ [SD]), located within
159 Auckland, New Zealand. The average length of confinement for a LD was 140 ± 119
160 days and 3.4 ± 0.8 days for a SD dog. The age of dogs in SD and LD could only be
161 approximated by shelter staff, therefore dogs were categorised into three groups: juvenile
162 (< 18 months; $n = 5$), adult (> 18 months < 8 years; $n = 21$) and senior (> 8 years; $n = 3$).
163 Four of the dogs were purebred (Alaskan Malamute $n = 1$; Labrador $n = 1$; Poodle $n = 1$;
164 Samoyed $n = 1$) and the remainder crossbreed.

165

166 *2.2 Daily husbandry*

167 Dogs at Shelter A were individually kept in concrete-floored kennels consisting of two
168 sections: an indoor section ($2.5 \text{ m} \times 1.5 \text{ m}$; length x width), containing a wooden bed, and
169 an outdoor section ($3.5 \text{ m} \times 1.5 \text{ m}$; length x width). The outside section of the kennel was
170 comprised of wire allowing dogs to see other dogs in neighbouring kennels. The two
171 sections were connected by wooden doors that could be closed overnight. A water bowl
172 was provided in the kennel and feeding took place twice a day at approximately 10:00 h
173 and 14:00 h. The dogs were confined to the indoor section of their kennel from 18:00 h to
174 07:00 h. Each dog was moved to a larger outdoor concrete run for 30 min per day so that
175 their kennel could be cleaned (between 08:00 h and 10:00 h). Dogs could not socially
176 interact.

177

178 Dogs at Shelter B were individually kept in concrete-floored kennels ($3 \text{ m} \times 1.5 \text{ m}$; length
179 \times width) with a wooden bed raised off the ground at the far end of the kennel. Each
180 kennel had solid sides preventing dogs from visualising other dogs in the shelter. The

181 dogs were individually let out into a grass exercise area twice daily for 30 min at a time;
182 once in the morning during cleaning (between 08:00 h and 10:00 h), and once in the
183 afternoon after feeding (between 13:00 h and 15:00 h). The dogs were fed once a day at
184 approximately 12:00 h. In both shelters staff did not interact with dogs other than
185 transporting them to the exercise areas.

186

187 The pet dogs were housed in family homes and had various routines depending on the
188 owners' work schedule. Four of the 10 PD dogs were taken to work on a daily basis with
189 their owners. The remaining 6 PD dogs were left at home for between 6 - 8 h per day
190 inside the house.

191

192 *2.3 Video recording*

193 *2.3.1 Home environment (HE) recordings*

194 The behaviour of each LD dog was videoed for 1 h continuously over four consecutive
195 days at 10:00 h. For each LD dog, recording occurred between 1 - 11 months after
196 admission to the shelter dependent on the length of time each dog had been resident when
197 the study began (1 month n = 3 dogs; 3 months n = 2 dogs; 4 months n = 1 dogs; 8
198 months n = 1 dog; 10 months n = 1 dog). After completing the videoing of the LD group
199 it emerged that the same sampling method could not be used for the SD group given the
200 high risk of the dogs in this group being re-homed within the 4 day period. It was
201 therefore decided that video footage for both SD and PD dogs would be collected for 4 h
202 continuously on a single day from 10:00 - 12:00 h and 1500 -17:00 h. SD recording
203 occurred between 2 - 4 days after admission to the shelter dependent on the arrival date of
204 each dog at the start of the study (2 days n = 3; 3 days n = 2; 4 days n = 5). The PD
205 subjects were filmed in the location where the PD dog's bed was located and where the
206 dog was normally left when the owner was out.

207

208 For each dog this location varied i.e. bedroom (n = 3), garage (n = 2), lounge (n = 1), or,
209 if dogs were regularly taken to work with their owner, an office space (n = 4). All dogs

210 were filmed using a Sony DV21E 'Handy Cam' (Sony New Zealand, Auckland, New
211 Zealand) placed on a tripod opposite the kennel or in the corner of the room where the
212 dog was left when the owner was out. In total 4 h of video footage was collected for each
213 dog in the study. At Shelter A, AM recording began directly after feeding and 0 - 2 h after
214 exercise (LD and SD). PM recording began 1 h after both feeding and exercise (SD). At
215 Shelter B, AM recording began 0 - 2 h after exercise and 2 h prior to feeding (LD and
216 SD). PM recording began 3 h after both feeding and exercise (SD). AM recording of PD
217 dogs began a minimum of 2 h after feeding and exercise, whilst PM recording began a
218 minimum of 7 h after feeding and exercise.

219

220 For the purposes of QBA analysis (see section 2.6: Qualitative Behavioural Assessment),
221 a 1 min video clip was isolated from the total 4 h recorded for each dog in the HE. In
222 order to standardise the selection of this clip, extraction occurred at exactly 150 min into
223 the total recording time. It was thought that after this time dogs would have habituated to
224 the presence of the camera regardless of whether recording took place in 1 h bouts or a
225 continuous 4 h session.

226

227 2.3.2 Novel Environment (NE) recordings

228 Additionally, for the purposes of QBA analysis pertaining to a novel environment (see
229 section 2.6: Qualitative Behavioural Assessment), each dog was placed in a purpose-
230 made aluminium portable test pen (9 m²) 1 day subsequent to the completion of HE
231 recording. Each side of the test pen comprised seven slatted horizontal aluminium bars,
232 fitted inside an aluminium frame. The test pen was set up outdoors in a location
233 unfamiliar to the dogs. For the SD and LD dogs this was a grass area located at the back
234 of both animal shelters that the dogs had not previously been, and for the PD left at home
235 it was on a neighbouring property, for those dogs taken to work it was on a nearby
236 football field. The behaviour of each dog in this NE was video-recorded for 1 min. Each
237 dog was removed from his/her kennel, office or home by the researcher and walked on-
238 lead < 500 m to the location of the test pen and placed inside. Recording commenced

239 immediately after the researcher had placed the dog into the test pen and had walked out
240 of view of the dog. No other people were present during the NE recording. This recording
241 resulted in 29 NE clips. Thus a total of 58 video clips were collected for QBA: 29 HE and
242 29 NE clips.

243

244 *2.4 Saliva cortisol sampling*

245 Saliva samples were taken from each dog at the end of filming the HE (sample collection
246 took place at 11:30 h for LD and 17:30 h for both SD and PD). A saliva sample was taken
247 from the dog's cheek pouches with a cotton salivette (Salivette Systems, Sarsted
248 Australia Pty LD, Mawson Lakes, South Australia). Samples were collected in duplicate
249 to ensure an adequate amount of saliva was obtained for each dog. The cotton salivettes
250 were infused with citric acid, which stimulates saliva flow, and were rotated in the dogs'
251 cheek pouch for 1 min. Each cotton salivette was replaced in its tube and put on ice. The
252 cotton salivettes were centrifuged within 4 h of collection at 4000rpm for 10 min and
253 cooled down to a temperature of -20°C. The samples were analysed by Gribbles
254 Veterinary Pathology located in Hamilton (New Zealand).

255

256 *2.5 Quantitative scores of behaviour*

257 The video recordings were used to continuously record the behaviour of the dogs for 4 h,
258 using Observer XT software (Noldus Information Technology, V7, 2007, Wageningen,
259 the Netherlands). The dogs' behaviour was categorised on the basis of an ethogram with
260 26 distinct behaviour categories (Table 1). Using the same equipment and categorisation,
261 the dogs' behaviour was also recorded in the 29 HE and 29 NE video clips of 1 min
262 length. Any behaviour occurring less than three times were excluded from analysis.
263 Behaviour analysis and data transformation can be found in Table 1.

264

265 *2.6 Qualitative Behavioural Assessment (QBA)*

266 *2.6.1 Observers*

267 Ten female observers, recruited through email advertisements sent to undergraduate

268 students, provided qualitative assessments of the dogs' behaviour. All observers had
269 previous experience interacting with dogs; five worked with dogs on a daily basis and had
270 previous experience observing dogs, whilst the remaining five were students studying
271 animal behaviour. None of the observers had previous experience with Qualitative
272 Behaviour Assessment (QBA) or Free Choice Profiling (FCP) methodology.

273

274 *2.6.2 Experimental procedures*

275 To generate data a FCP methodology was used as described in Wemelsfelder et al.
276 (2001), and for dogs in Walker et al. (2010). In summary, FCP asks the observers to
277 generate their own descriptive vocabulary based on direct observations of the animals,
278 and thus facilitates the active interpretation by observers of these animals' expressions,
279 rather than providing them with pre-selected descriptive terms (Walker et al., 2010). Our
280 10 observers were instructed in FCP procedures in session 1 (term generation). During
281 this session the observers generated their own descriptive vocabularies by watching the
282 58 dog clips and by writing down adverbs after each clip that in their view described the
283 dog's emotional expression. The observers were shown 29 HE followed by 29 NE clips
284 in a randomised order on a 17" computer monitor (MacBook Pro, Apple, Cupertino CA,
285 USA). A refreshment break was provided between HE and NE clips. In session 2
286 (quantification), observers were provided with a compilation of their personal terms
287 generated in session one, each term set next to a visual analogue scale (0 - 125 mm). The
288 observers then watched the same videos shown in session 1, HE clips before the break
289 and NE clips after the break, but shown in a different randomised order to session 1. After
290 each clip, observers scored the dog shown in that clip on each of their personal terms, by
291 marking the visual analogue scale at a point deemed appropriate. Session 3
292 (quantification 2), took place one day after session 2, and was aimed at testing the intra-
293 observer reliability of observer assessments. It was a replication of session 2, except that
294 the video clips were shown in a different randomised order to session 1 and session 2.
295
296 By the end of session 3, the 10 observers had used their personal rating scales to produce

four sets of scores (two for HE and two for NE) for all 29 dogs. For each observer, the two HE score sets were entered into one data matrix defined by the number of dogs (2×29) and the number of terms used by the individual observer, and the same was done for the two NE score sets. Thus a total of $10 \times 2 = 20$ individual observer data matrices were created.

302

2.7 Statistical analysis

2.7.1 Quantitative scores of behaviour

Analysis of ethogram-based data was carried out using Minitab (version 15) for Windows (Minitab Pty Ltd, Sydney NSW, Australia). For each of the 21 behaviour categories a one-way ANOVA, followed by a post-hoc Tukey test, was used to identify differences between the three treatment groups. Due to repeated testing of some data, Bonferroni adjustments were applied with an alpha level of $P < 0.0025$. Categorical data were investigated using Goodness of Fit Chi Squared test, to investigate behavioural differences amongst the three groups, compared to a null hypothesis that behaviour occurred with equal frequency across the three groups.

313

The distribution of dogs within both the LD and SD group was unbalanced across the two animal shelters. General Linear Model was used to investigate whether shelter location had a significant effect on behaviour.

317

Differences in cortisol concentrations between the three housing conditions were tested using the Kruskal-Wallis H test. Spearman's Rank Correlation Coefficient was used to investigate correlations between saliva cortisol levels and the performance of individual behaviour. Non-parametric statistics were employed as the residuals did not follow normal distribution (assessed using Anderson-Darling) when we attempted to fit parametric models, even when data were transformed.

324

2.7.2 Qualitative behavioural assessment

326 In the first instance, to investigate intra-observer reliability (see section 2.6.2), the
327 combined HE and NE data matrices from session 2 and 3 were analysed using GPA
328 (Genstat 2008, VSN International, Hemel Hempstead, Hertfordshire, UK, Wemelsfelder
329 et al., 2000). Secondly, the HE and NE data matrices from session 2 were analysed
330 separately using GPA and these results were used to compare treatments. To briefly
331 summarise, GPA detected the level of consensus between observer scoring patterns on
332 the basis of inter-sample distances specified by each observer. The calculation is
333 essentially a process of complex pattern recognition and takes places independently of the
334 meaning of the terminologies used by the observers. How well each individual observer's
335 scores fitted the consensus profile was quantified by the Procrustes statistic and expressed
336 as an 'observer plot' (Wemelsfelder et al., 2000). The statistical significance of this
337 consensus was then evaluated against a mean randomised profile, obtained by re-running
338 GPA with randomised observer data sets a hundred times. A one-tailed student t-test ($n =$
339 100) was used to determine whether the consensus differed significantly from the mean
340 randomised profile.

341

342 *2.7.3 Interpreting the GPA dimensions*

343 The consensus profile can have as many dimensions as the largest number of terms
344 generated by any of the 10 observers. To allow interpretation, this number was reduced
345 through PCA to three main consensus dimensions explaining the majority of variation
346 between the observed dogs. These main consensus dimensions were then correlated to the
347 original observer data matrices producing two-dimensional interpretive word-charts, one
348 for each of the 10 observers. All the terms of a particular observer were correlated with
349 the principle axes of the consensus profile and the higher the correlation of the term the
350 more weight it had as a descriptor of that axis. Semantic consistency seen between
351 observer charts made it possible to select representative labels to interpret the main
352 consensus dimensions. GPA produced a quantitative score for each dog on each QBA
353 dimension, represented graphically on the consensus sample plots. This score was used to
354 evaluate the differences between individual dogs and subsequently in combination with

355 ethogram-based quantitative behaviour data (see section 3.5.2).

356

357 *2.7.4 The Relationship between qualitative and quantitative measures of dog behaviour*

358

359 To investigate the relationship between QBA assessments of the dogs' behaviour and
360 ethogram-based quantitative behavioural analysis, in both the HE and NE, we employed a
361 form of 'data mapping' described in Minero et al. (2009). First, Principal Component
362 Analysis (PCA; covariance matrix, no rotation) was performed on the ethogram-based
363 quantitative behaviour data. This resulted in the attribution of scores to individual dogs on
364 the two main factors of this PCA. These PCA factors were subsequently used as the
365 frame onto which both ethogram-based quantitative behaviour data and QBA assessments
366 of individual dogs were mapped. To achieve this Spearman Rank Correlation Coefficient
367 was used to correlate the original ethogram-based quantitative behaviour score for each
368 behavioural category to the individual qualitative dog score, on each QBA dimension,
369 produced during the GPA process. The r-values resulting from these correlations served
370 as the coordinates to which each behavioural category and GPA dimension was mapped
371 onto the PCA factors in a two-dimensional plot.

372

373 Treatment effects along the first two factors of the ethogram-based quantitative behaviour
374 PCA were analysed using one-way ANOVA for the NE and Kruskal Wallis for the HE
375 environment.

376

377 **3. Results**

378 *3.1 Quantitative scores of behaviour*

379 Of the 21 behavioural categories analysed over a 4 h period, 12 of the 21 showed
380 significant treatment differences. Differences were found for 'walk', 'stand', 'rest', 'sit',
381 and 'lip-lick' behaviour (Table 2). Pet dogs spent more time resting and showed lower
382 levels of active behaviour (walking, standing and sitting) than SD and LD dogs. Pet dogs
383 also lip-licked less than dogs in the other two treatments.

384

385 Treatment differences were found in the performance of rare behaviour, with the
386 occurrence of 'paw-lift', 'drink', bark', 'whine', 'tail-wag', and 'pant', lower for PD than
387 for SD and LD dogs. The performance of 'sniff' was lower, whilst 'dig' was higher, for
388 SD dogs compared with PD and LD dogs (Table 2).

389

390 *3.2 Kennel environments*

391 Minimal difference was found between the dogs housed at the two different animal
392 shelters for any of the 21 behaviour recorded. This suggests that housing and husbandry
393 routine had little or no effect on the presence and duration of the observed behavioural
394 categories.

395

396 *3.3 Salivary cortisol*

397 Out of the 29 saliva samples obtained, only 18 of the samples contained a sufficient
398 quantity for analysis (PD n = 6; SD n = 7; LD n = 5). There was no significant difference
399 in the mean cortisol levels between the three groups of dogs ($H = 0.550$, $df = 2$, $P =$
400 0.760). There were no significant correlations between the performance of individual
401 behaviour over the 4 h period and cortisol concentrations.

402

403 *3.4 Qualitative behaviour assessment*

404 *3.4.1 Observer consensus*

405 The consensus profiles for the HE and NE assessments both explained a significantly
406 higher percentage of the variation between the observer matrices than the mean of 100
407 randomised profiles (Table 3). This indicates that the variation explained by these
408 consensus profiles is not an artefact of the statistical GPA procedures.

409

410 *3.4.2 Intra-observer reliability*

411 The scores attributed by observers to individual dogs in the two repeat studies of HE and
412 NE assessments were correlated highly significantly across all three consensus

413 dimensions of these assessments ($0.78 < r < 0.97$, all $P < 0.001$), indicating that observers
414 had repeated their qualitative assessment of individual dogs with considerable accuracy.
415 Given this high level of repeatability, only data from session 2 will be presented in the
416 following results. For more detailed discussion of QBA quantitative dog scores see 3.4.4.

417

418 *3.4.3 Dimensions of dog behavioural expression*

419 Dimension 1 of the HE assessment explained 68.8%, dimension 2 11.2%, and dimension
420 3 5.4% of the variation between dogs, giving a total of 85.4% of the variation explained.

421 Dimension 1 of the NE assessment explained 46.1%, dimension 2 18%, and dimension 3
422 11.8%, of the variation between dogs, giving a total of 75.9% of the variation explained.

423

424 Fig. 2 shows, as an example, both HE and NE word charts pertaining to one observer.

425 These word charts display all the terms utilised by that observer to describe the dogs'
426 behavioural expression in both the HE and NE treatments and visually illustrates (highest
427 and lowest loading variables on each axis) the observer's terms that best correlate with
428 the three main consensus dimensions of these assessments; i.e. this observer described
429 HE dimension one as ranging from 'relaxed/sleepy' to 'stressed/anxious', and NE
430 dimension one as 'calm/relaxed' - 'anxious/stressed'. HE dimension two was described as
431 'interested/alert' to 'lethargic/depressed', and NE dimension two as 'curious/active' -
432 'confused/calm'. HE dimension three was described as 'calm/watchful' -
433 'frustrated/bored' and NE dimension three as 'hyperactive/ anxious – curious/cautious'.

434

435 To provide an overview of all observers' terms, Table 4 lists the terms (two for each
436 observer) that correlated most strongly with each of the three consensus dimensions of
437 the HE and NE assessments. This table shows that a considerable number of observers
438 used the same terms to describe the different dimensions. For example, in the NE
439 assessment all 10 observers used the term 'calm' in their top two descriptors for the
440 positive end of dimension 1. Where observers used different terms, the meanings of these
441 terms tended to be either similar in mood/tone (e.g. 'stressed/anxious/agitated/frustrated'

442 and ‘curious/inquisitive/investigative’) or complement each other in mood/tone (e.g.
443 ‘confident/alert’, ‘awkward/worried’). In some cases, terms on the second or third
444 dimension appear to contradict each other in tone (e.g. ‘alert’, ‘calm’); as the percentage
445 of variation explained by a dimension lowers (e.g. dimension 3), the more likely it
446 becomes that high-loading terms lack consistency of meaning. On the basis of this table,
447 we labelled HE dimension 1 as ‘relaxed/content – stressed/anxious’, dimension 2 as
448 ‘confident/excited – depressed/bored’, and dimension 3 as ‘alert/attentive –
449 agitated/frustrated’. For the NE assessment we labelled dimension 1 as ‘calm/relaxed –
450 excited/anxious’, dimension 2 as ‘curious/inquisitive – confused/unsure’, and dimension
451 3 as ‘confident/agitated – ‘cautious/curious’. These labels will be used throughout the
452 remainder of the paper.

453

454 *3.4.4 Qualitative behavioural analysis treatment effects*

455 A significant effect of treatment on observer attribution of scores to dogs (QBA
456 quantitative dog scores) was found for HE dimension 1 ($H = 17.86$, $P < 0.0001$). Post-hoc
457 analysis showed the PD group to appear significantly more ‘relaxed/content’ than the
458 other two groups (Fig. 3). In the NE assessment a treatment effect was observed across all
459 three dimensions (dimension 1: $H = 13.58$, $df = 2$, $P < 0.001$; dimension 2: $H = 5.97$, $df =$
460 2 , $P < 0.05$; dimension 3: $H = 6.82$, $df = 2$, $P < 0.05$). Post-hoc analysis showed that on
461 dimension 1 the PD group appeared more ‘calm/relaxed’ than the other groups; that on
462 dimension 2 the LD group appeared more ‘inquisitive/curious’ than the other groups, and
463 on dimension 3 the SD group appeared more ‘cautious/curious’, than other groups (Fig.
464 3).

465

466 *3.5 The Relationship between qualitative and quantitative measures of dog behaviour*

467 *3.5.1 Quantitative analysis of dog behaviour in the QBA video clips*

468 PCA of the ethogram-based behaviour data showed two main factors explaining 61.8%
469 and 26.4% of the variation in the HE assessment, and 40.8% and 35% of the variation in
470 the NE assessment. Table 5 shows the loadings of ethogram behavioural categories on to

these factors. Thus for the HE assessment, PCA factor 1 was represented at the negative end by ‘rest’, and at the positive end by ‘vocal’, ‘stand’ and ‘walk’ (Table 5). There was a significant effect of treatment on this factor ($H = 9.35$, $df = 2$, $P < 0.01$). Post-hoc analysis revealed that seven out of 10 dogs in the PD group loaded highly negatively on PCA factor 1, reflecting a greater incidence of resting in this group than in other groups. PCA factor 2 was characterised by ‘vocal’ at the negative end and ‘stand’, ‘walk’ and ‘jump’ at the positive end, however there was no significant effect of treatments in the factor 2 scores.

For the NE assessment, high loading variables on the first PCA factor (explaining 40.8% of the variation) were ‘vocal’ on the negative end, and ‘stand’ and ‘sniff’ on the positive end (Table 5). There was no effect of treatment on PCA factor 1. Factor 2 (explaining 35% of the variation) was characterised by ‘stand’, ‘walk’ and ‘sniff’ on the negative end and ‘pant’ on the positive end. There was a significant effect of treatment on PCA factor 2 ($H = 11.01$, $df = 2$, $P < 0.005$). Post-hoc analysis revealed that dogs in the PD group clustered at the negative end of the axis suggesting that PD dogs were standing, walking and sniffing more and panting less during the NE assessment than SD and LD dogs.

3.5.2 Correlation between quantitative and qualitative behaviour assessments

HE QBA dimension 1 (‘relaxed/content – stressed/anxious’) correlated positively with ‘rest’ ($r = 0.47$, $P < 0.01$) and negatively with ‘stand’ ($r = -0.71$, $P < 0.0001$), ‘walk’ ($r = -0.71$, $P < 0.0001$), ‘jump’ ($r = -0.69$, $P < 0.0001$), ‘vocal’ ($r = -0.77$, $P < 0.0001$), ‘pant’ ($r = -0.38$, $P < 0.05$), ‘dig’ ($r = -0.47$, $P < 0.01$) and ‘lip lick’ ($r = -0.58$, $P < 0.001$). No significant correlations were found between HE QBA dimension 2 (‘confident/excited – depressed/bored’) and behaviour. HE QBA dimension 3 correlated negatively with ‘walk’ ($r = -0.37$, $P < 0.05$), ‘jump’ ($r = -0.56$, $P < 0.005$) and ‘vocal’ ($r = -0.359$, $P < 0.05$).

Fig. 4 presents a visual representation of the association between ethogram-based quantitative behaviour scores and QBA qualitative dog scores, when positioned in

reference to the axes generated by PCA analysis of quantitative behavioural variables (see section 2.7.4). HE QBA dimension 1 ('relaxed/content-stressed/anxious') was significantly correlated with PCA factor 1 ($r = -0.791$, $P < 0.0001$), indicating that dogs engaging in resting behaviour were assessed as relaxed/content while dogs engaging in vocalising, walking and standing behaviour were characterised by observers as 'stressed/anxious'. The correlations of HE QBA dimension 2 with PCA factor 1 and PCA factor 2 were not significant ($r = 0.165$; ns and $r = 0.148$; ns, respectively), nor were the correlations of HE QBA dimension 3 with PCA factor 1 or PCA factor 2 ($r = -0.27$; ns and $r = -0.085$; ns, respectively). No significant correlations were found between the QBA dimensions and cortisol concentrations or between individual behaviour categories and cortisol concentrations in the HE environment.

511

NE QBA dimension 1 ('calm-relaxed – excited/stressed') correlated negatively with 'walk' ($r = -0.44$, $P < 0.05$), 'run' ($r = -0.55$, $P < 0.005$), 'jump' ($r = -0.43$, $P < 0.005$) and 'vocal' ($r = -0.59$, $P < 0.001$). NE QBA dimension 2 ('curious/inquisitive–confused/unsure') was positively correlated with 'stand' ($r = 0.44$, $P < 0.05$) and 'urinate' ($r = 0.59$, $P < 0.001$) and negatively with 'pant' ($r = -0.39$, $P < 0.05$). NE QBA dimension 3 was negatively correlated with 'stand' ($r = -0.39$, $P < 0.05$), 'walk' ($r = -0.41$, $P < 0.05$) and 'paw lift' ($r = -0.48$, $P < 0.01$).

519

NE QBA dimension 1 was significantly correlated with PCA factor 1 ($r = 0.371$, $P < 0.05$) indicating that dogs engaging in standing and sniffing behaviour were assessed as 'calm/relaxed'. NE QBA dimension 2 correlated with PCA factor 2 ($r = -0.374$, $P < 0.05$) indicating that dogs engaging in sniffing, walking and standing behaviour were perceived as curious/inquisitive. NE QBA 3 significantly correlated with PCA factor 2 ($r = 0.360$, $P = 0.055$) indicating that dogs performing panting and lip-licking were perceived as confident/agitated. No significant correlations were found between the QBA dimensions and cortisol concentrations or between individual behaviour categories and cortisol concentrations in the NE environment.

529

530 **4. Discussion**

531

532 We compared Qualitative Behavioural Assessment (QBA) to quantitative assessment of
533 behaviour and physiology of dogs in three types of housing (short-term shelter
534 confinement (SD), long-term shelter confinement (LD) and domestic living situations
535 (PD)). Both quantitative behaviour assessment and QBA revealed significant differences
536 among the three groups. Combining these measures through correlation and multivariate
537 analysis produced significant results validating the usefulness of QBA as a tool for
538 monitoring behaviour in shelter-housed dogs.

539

540 Our findings demonstrate that the shelter-housed and pet dogs differed in the behaviour
541 they displayed over the four hours of observation. Shelter-housed dogs showed longer
542 average durations of active behaviour, and higher frequencies of tail-wagging, paw-
543 lifting, panting, barking, whining and drinking than the pet dogs, whilst pet dogs rested
544 for longer periods of time. This marked difference supports the suggestion by other
545 authors that the behaviour of pet dogs can provide a baseline against which that of dogs in
546 other housing conditions can be compared (e.g. Hennessey et al., 1997, Beerda et al.,
547 2000 and Viggiano et al., 2009). Additionally, the increased behavioural arousal observed
548 in the shelter-dogs suggests that these individuals may have experienced increased stress
549 comparative to the pet dogs in the study (Hiby et al., 2006). Although behaviour
550 predominately differed between shelter-housed dogs and pet dogs, 3 out of 21 behaviour
551 categories were additionally observed to differ between the SD and LD groups. The SD
552 group displayed increased standing and digging behaviour and decreased sniffing
553 behaviour comparative to the LD group, which might reflect the on-going adjustment of
554 the SD group to the shelter environment.

555

556 The salivary cortisol concentrations among the three groups of dogs did not differ
557 significantly. There are a number of possible explanations for our non-significant cortisol

findings. Firstly, only 18 (out of a total of 29) of the samples contained sufficient saliva for analysis meaning each treatment group had less than (or equal to) seven individuals possibly contributing to reduced statistical viability. Also, Hennessy et al. (2001) suggests that after the first three days in a shelter environment, plasma cortisol levels tend to decrease as dogs become habituated to their environment. Since six of the seven samples collected from our SD group and all of the samples from the LD group were obtained from dogs that had already been in the shelter for 4 (or more) days, it is possible that cortisol levels had already decreased. Furthermore, Rooney et al. (2007) suggest that dogs that have previously been habituated to a kennel environment may experience a less dramatic increase in cortisol levels, unfortunately information pertaining to previous detainments was unobtainable for the dogs in our study. It is also well known that prolonged stressors (such as long term kennelling) resulting in high levels of glucocorticoid can exert inhibitory effects on the central and pituitary level of the HPA axis. This can result in increasing resilience and a reduction in the level of cortisol response (Beerda et al., 1998 and Hennessy et al., 2001). It is also worth considering the possibility of individual breed as an influencing factor, however 86% of our sample population were crossbreed dogs. Finally, the time of day when sampling occurred varied between the three groups. The collection of saliva samples took place at varying times of day likely contributing to increased variability between individuals (Hennessy, 2013). Taken as a whole, these various factors may help to explain the variation in cortisol levels between individuals and the lack of significance observed between groups.

579

Our observer group showed significant agreement in their assessments of dog expression, and identified three main consensus dimensions in both HE (QBA dimension 1: ‘relaxed/content-stressed/anxious’; QBA dimension 2: ‘confident/excited-depressed/bored; and QBA dimension 3: ‘alert/attentive-agitated frustrated’) and NE (QBA dimension 1: ‘calm/relaxed-excited/anxious’; QBA dimension 2: ‘curious/inquisitive-confused/unsure’; and QBA dimension 3: ‘confident/agitated-cautious/curious’) environments. The qualitative dimensions for dog behavioural

587 expression that we describe in this study are comparable to ones we described in a
588 previous study, e.g. ‘playful/happy/confident’ to ‘nervous/unsure/tense’ and
589 ‘alert/inquisitive/investigative’ to ‘attention-seeking/quiet/unsure’(Walker et al., 2010)
590 suggesting that qualitative dimensions of dog behavioural expression are relatively stable
591 across differing observers, environments and dogs. Recent QBA research has looked at
592 the use of engaging a standardised list of QBA terms, rather than allowing observers to
593 generate their own term list, ultimately saving time and the number of observation
594 sessions required (e.g. Andreasen et al., 2013 and Phythian et al., 2013). A standardised
595 list of QBA terms could potentially provide a mechanism for allowing QBA methodology
596 to be a useful and practical tool in the daily monitoring of behaviour in kennelled dogs,
597 preferably in combination with a selection of specific quantitative indicators (see for
598 example Kessler and Turner (1997), for cats, and Wiseman-Orr et al. (2011), for pigs).
599 The comparability of the terms generated to describe dog behavioural expression in the
600 present study and in our previous work (see Walker et al., 2010) suggest that a
601 standardised list of terms could be robust and feasible. Future research could develop
602 such lists, test their inter- and intra-observer reliability, and cross-validate their relevance
603 to welfare with accepted indicators for dog health and well-being.

604
605 Our QBA results combined meaningfully with our quantitative behavioural analysis. The
606 PD group loaded alongside ‘rest’ in the HE and alongside ‘stand’, ‘walk’ and ‘sniff’ in
607 the NE. Thus for the PD group, both inactivity (resting) and explorative behaviour
608 (walking/standing/sniffing) were perceived by observers to reflect content/calm/relaxed
609 dogs. The LD group loaded alongside QBA variables ‘curious/inquisitive’ in the NE,
610 which correlated with quantitative variables ‘walk’, ‘stand’ and ‘sniff’, indicating that the
611 LD group behaved in an explorative manner in the NE, but were not perceived to be as
612 calm and relaxed as PD dogs while doing so. The SD group loaded alongside QBA
613 variables ‘cautious/curious’ in the NE, which correlated with ‘stand’, ‘walk’ ‘paw-lift’
614 and ‘sniff’. In this context the QBA descriptor ‘cautious’, combined with the presence of
615 a traditional behavioural stress indicator (paw-lifting), may reflect a more anxious or

616 stressed group of dogs. Thus, QBA assessments appeared to map meaningfully onto
617 quantitative behaviour assessments, and to be helpful in interpreting these in terms of an
618 animal's overall state. This supports the finding of previous studies that both types of
619 measurement can complement and strengthen each other in studies of animal behaviour
620 (e.g. Minero et al., 2009 and Rutherford et al., 2012).

621

622 Research has documented significant associations between QBA dimensions and a range
623 of physiological measures in cattle including; core body temperature, heart rate, plasma
624 glucose, neutrophil:lymphocyte ratios and plasma lactate concentrations measured at
625 exsanguinations (Stockman et al., 2011 and Stockman et al., 2012). Such findings suggest
626 that the differences in behavioural expression identified by observers in QBA studies are
627 validated by physiological measures. In the present study no correlations were found
628 between salivary cortisol concentrations and QBA dimensions in either the HE or NE
629 environments. Taking into consideration the number of limitations previously discussed,
630 other research identifying correlations between physiological measures and QBA
631 dimensions and the meaningful relationship evidenced between QBA dimensions and
632 quantitative measurement of behaviour in the present study, it seems plausible to suggest
633 that the non-existent relationship between QBA dimensions and cortisol concentrations
634 resulted from methodological difficulties. Future research is required to establish if and
635 how physiological measures of stress in dogs correlate meaningfully to QBA dimensions.

636

637

638 **5.0 Conclusion**

639

640 Quantitative ethogram-based behavioural observations identified a significant difference
641 between our shelter-housed and pet dogs during the observation period. Pet dogs (PD)
642 spent more time resting and showed lower levels of active behaviour (sitting, standing
643 and walking) in comparison to dogs in both short (SD) and long (LD)-term confinement
644 which showed a significantly higher frequency of behaviour that is potentially indicative

of stress including; paw-lifting, displacement behaviour (e.g. digging or drinking), excessive vocalisations and increased locomotory activity. These quantitative findings were complimented in the 1 min observations by QBA. QBA dimension 1 in the HE environment (relaxed/content-stressed/anxious') and all 3 QBA dimensions in the NE environment (1: calm/relaxed-excited/anxious', 2: 'curious/inquisitive-confused/unsure' and 3: 'confident/agitated-cautious/curious') correlated significantly and meaningfully with quantitative behavioural measurements, validating the QBA as a tool for behavioural evaluation in shelter-housed dogs. Both qualitative and quantitative methods were able to extract key differences among the three dog groups, suggesting that future research utilising traditional quantitative behavioural observations can be strengthened by the addition of QBA.

656
657

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659

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666

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Table 1: Ethogram

Behaviour Categories	Description of Behaviour
Locomotive Behaviour	
Walk ^{a, d}	Forward movement with legs resulting in shift of whole body to new position in enclosure. No more than one paw is off the ground at any one time.
Run ^{b, d}	As walking but faster paced where multiple paws leave the ground at the same time.
Stand ^{a, d}	All four paws on ground and legs upright and extended supporting body.
Rest ^d	Ventral/lateral lying on ground with all four legs resting and in contact with ground. Dog may also be curled up in a tight ball. Head is either resting on ground or held up in air. Eyes are either open or closed.
Sit ^{a, d}	Hind quarters on ground with front two legs being used for support.
Circle ^{b, d}	A circular motion is traced in one direction (or on the spot) repeatedly.
Jump ^f	Dog has both hind legs on the floor and rears in a manner that results in both forelegs in contact with the wall or bars of enclosure. This behaviour also includes dogs that are observed with all four legs off the ground.
Paw Lift ^{b, f}	Front limb is raised and lowered often in quick succession.
Stretch ^d	Dog moves body into playbow position by extending front legs and lowering chest and head towards the ground.
Maintenance Behaviour	
Eat ^{b, d}	Dog ingests food provided by kennel attendant.
Drink ^{b, d}	Dog drinks from automated water system or bowl provided.
Urinate ^f	Dog excretes urine.
Defecate ^f	Dog excretes faecal material.
Vocal Behaviour	
Bark ^{b, f, #}	Mouth opens and then quickly closes in a snapping motion and a low frequency vocalisation is produced. Each bark is a short duration often performed in succession.
Howl ^{b, f, #}	Continuous medium pitched vocalisation which the subject performs with muzzle pointed skywards.
Whine ^{b, f, #}	Soft, high pitched, whistling vocalisation that occurs in short repeated bursts.
Yelp ^{f, b, f}	Loud (relative to whine) high pitched vocalisation of short duration.
Oral Behaviour	
Lip Lick ^{a, f}	Part of the tongue is shown and moved along the upper lip.
Yawn ^{b, f}	Mouth open wide for a period of a few seconds whilst exhaling.
Pant ^{b, d}	Mouth open with tongue extended accompanied with rapid breathing and expansion/contraction of chest.
Sniff ^{b, d}	Air inhaled forcibly through the nose.
Bite Kennel Wire ^d	Dog bites wire of kennel enclosure.
Other	
Groom ^{a, d}	Behaviours directed towards the subjects own body including licking, self-biting and scratching.
Dig ^{b, d}	The dog uses forepaws to repeatedly scratch the surface of the walls and floor.
Tail Wag ^{b, d}	Repetitive movement of the tail in a side to side motion.
Shake ^f	Rapid vibration of the whole body.

^a = data normalised by square root transformation

^b = data transformed to 0/1 categorical data

^d = behaviour recorded continuously (duration behaviour)

^f = behaviour recorded as single events (frequency behaviours)

[#] = behaviour combined into one category 'vocal' for analysis

* = behaviour excluded from analysis due to infrequency of occurrence (observed on < 3 occasions)

Table 2

Table 2: Behavioural differences between housing treatment groups based on 4 h observations in the home environment. SD = Short-term confinement dogs, LD= Long-term confinement dogs, PD = Pet dogs.

Significance: *** p<0.001; ** p<0.01; * p<0.05. Statistics are based on SQRT transformed data, or categorical transformation (0/1). Numbers shown under each treatment group are mean duration (\pm SD) [#] or total count ^{*} of behaviour performed during the 4 h observation. [#] Treatments on the same row that do not share a letter are significantly different from one another at p<0.05 (Tukey HSD post-hoc tests).

Behaviour	Housing Treatment			F-Ratio
	SD (n=10)	LD (n=9)	PD (n=10)	
Rest (seconds) [#]	8992 \pm 1551 ^a	8440 \pm 1887 ^a	12513 \pm 2836 ^b	10.12***
Sit (seconds) [#]	1498 \pm 772 ^{cd}	2908 \pm 2169 ^c	1424 \pm 2502 ^d	3.41*
Stand (seconds) [#]	3044 \pm 1140 ^e	1803 \pm 1610 ^f	325 \pm 296 ^g	25.32***
Walk (seconds) [#]	854 \pm 817 ^h	1085 \pm 916 ^h	750 \pm 139 ⁱ	9.82***
Lip Lick (count) [#]	27.5 \pm 14.5 ^j	54.4 \pm 32.4 ^j	6.1 \pm 5.9 ^k	18.5***
Pearson Chi-Sq (χ^2 value)				
Drink (0/1) [*]	1	10	6	13.64**
Sniff (0/1) [*]	9	4	9	10.98**
Bark (0/1) [*]	2	9	7	11.8**
Whine (0/1) [*]	1	9	8	17.6*
Tail Wag (0/1) [*]	2	10	9	20.99***
Paw Lift (0/1) [*]	1	8	8	15.03***
Dig (0/1) [*]	2	8	4	7.3**

Table 3: Consensus Parameters for HE and NE assessments. * indicates $P < 0.0001$

	HE assessment	NE assessment
	(Procrustes Statistic ± SD)	(Procrustes Statistic ± SD)
Consensus profile	73.70	55.06
Mean randomised profile	30.00± 0.13	31.4± 0.19
t_{99}	120.00*	54.01*

Table 4

Table 4. Terms (two for each of the 10 observers) that showed the highest positive and negative correlations with dimensions 1, 2 and 3 of the consensus profile for HE and NE assessments. The number in parentheses after some terms refer to the number of observers using that term, otherwise only one observer used that term.

HE assessment			NE assessment	
Consensus Dimension	Positive end	Negative end	Positive end	Negative end
1	Relaxed (6), Comfortable (3), Content (3), Sleepy (2), Calm (2), Quiet, Motionless, Tired, Laid Back.	Stressed (5), Anxious (4), Agitated (2), Frustrated (2), Alert, Bothered, Bored, Worried, Distracted, Aroused, Tense	Calm (10), Relaxed (7), Content, Quiet, Bored	Excited (4), Anxious (3), Stressed (3), Agitated (2), Aroused, Frustrated, Upset, Restless, Active, Stimulated, Tense, Desperate.
2	Confident (3), Stimulated (3), Excited (3), Interested (2), Curious (2), Inquisitive (2), Motivated, Alert, Observant, Nervous, Frightened.	Depressed (5), Bored (3), Resigned (2), Worried, Upset, Sad, Fearful, Indifferent, Lethargic, Lonely, Calm, Withdrawn, Tired.	Curious (5), Inquisitive (3), Active (3), Investigative (2), Stimulated (2), Dominant, Focused, Excited, Interactive, Content.	Confused (4), Unsure (2), Worried, Anxious, Awkward, Lonely, Fearful, Attentive, Calm, Nervous, Patient, Bored, Tense, Watchful, Attention-seeking, Alert.
3	Alert (4), Calm (3), Attentive (3), Resigned (2), Bored (2), Quiet, Submissive, Interested, Lazy, Watchful, Inquisitive.	Agitated (5), Frustrated (3), Sleepy (2), Confident (2), Stimulated, Excited, Lively, On-Edge, Bored, Bothered, Tense, Aggressive.	Confident (6), Agitated (2), Hyperactive (2), Restless, Excited, Aroused, Anxious, Alert, Aggressive, Attention-seeking, Happy, Dominant, Distracted.	Nervous (2), Wary (2), Curious (2), Inquisitive (2), Unsure (2), Worried, Focused, Alert, Submissive, Careful, Cautious, Nosy, Timid, Investigative, Scared.

Table 5. Principle component analysis (PCA) of quantitative behavioural data from 1 minute video clips taken in home (HE) and novel (NE) environments. The highest loading behaviours for each factor is shown in **bold**. Behaviours are left blank because they did not occur in that environment.

	HE Assessment			NE Assessment		
	Eigen Value	% of Variance Explained	Cumulative Variance Explained	Eigen Value	% of Variance Explained	Cumulative Variance Explained
PCA 1	13.876	61.8	61.8	14.43	40.8	40.8
PCA 2	5.929	26.4	88.3	12.38	35.0	75.7

Behaviour	PCA 1	PCA 2	PCA 1	PCA 2
Rest	-0.064	-0.095		
Sit	0.021	-0.006	0.004	0.028
Stand	0.301	0.586	0.124	-0.65
Walk	0.293	0.504	-0.056	-0.655
Run	0.003	0.025	-0.063	-0.126
Jump	0.126	0.402	-0.091	-0.056
Circle			-0.049	-0.001
Vocal	0.884	-0.44	-0.969	-0.069
Pant	0.033	0.156	-0.039	0.101
Drink	0.01	0.063		
Urinate			0.027	-0.034
Defecate			0.005	0.01
Groom	-0.003	0.006		
Dig	0.048	0.035	0.007	0.001
Sniff	0.031	0.005	0.129	-0.294
Tail Wag	0.098	-0.019	-0.093	-0.097
Paw Lift	0.012	0.016	0.02	-0.12
Stretch	-0.005	-0.001		
Bite Kennel Wire	0.008	0.051		
Shake			0.002	0.004
Lip Lick	0.085	0.051	0.009	0.052

Figure Captions:

Fig 1. Observer Plots. Axes reflect GPA scaling values for relative observer distance. Numbers represent individual observers. The dotted ellipse represents the 95% confidence region for what may be considered the normal population of observers.

Fig 2. Word Charts for observer 5. Axes reflect the level at which observer terms correlate to the three main dimensions of the consensus profile.

Fig 3. Dog score plots. Axes reflect the three main dimensions of the consensus profile for HE and NE assessments.

Figure 1

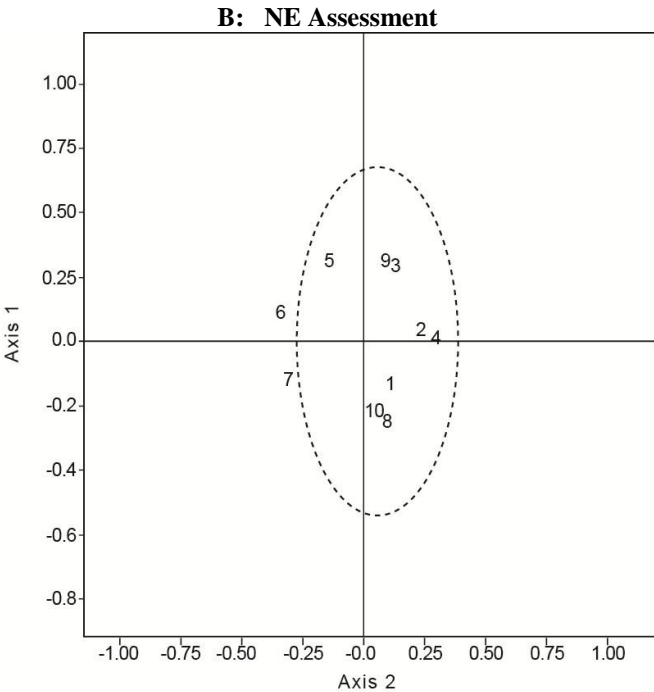
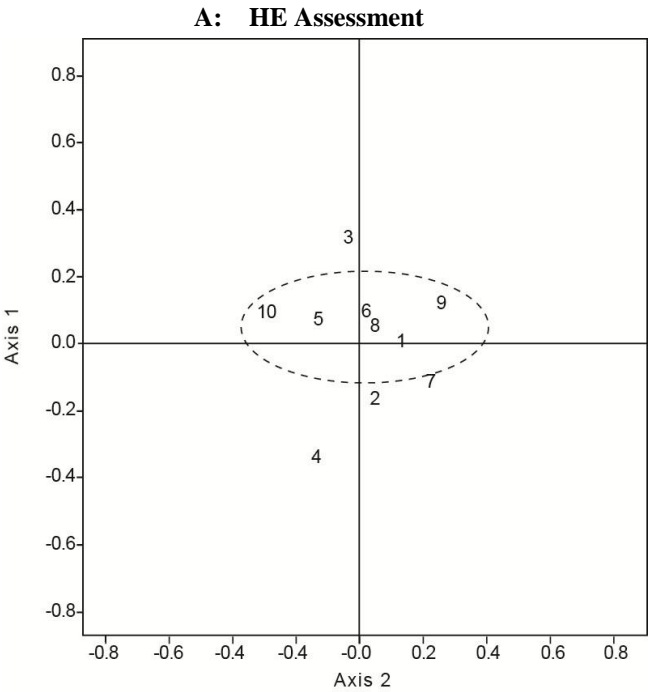
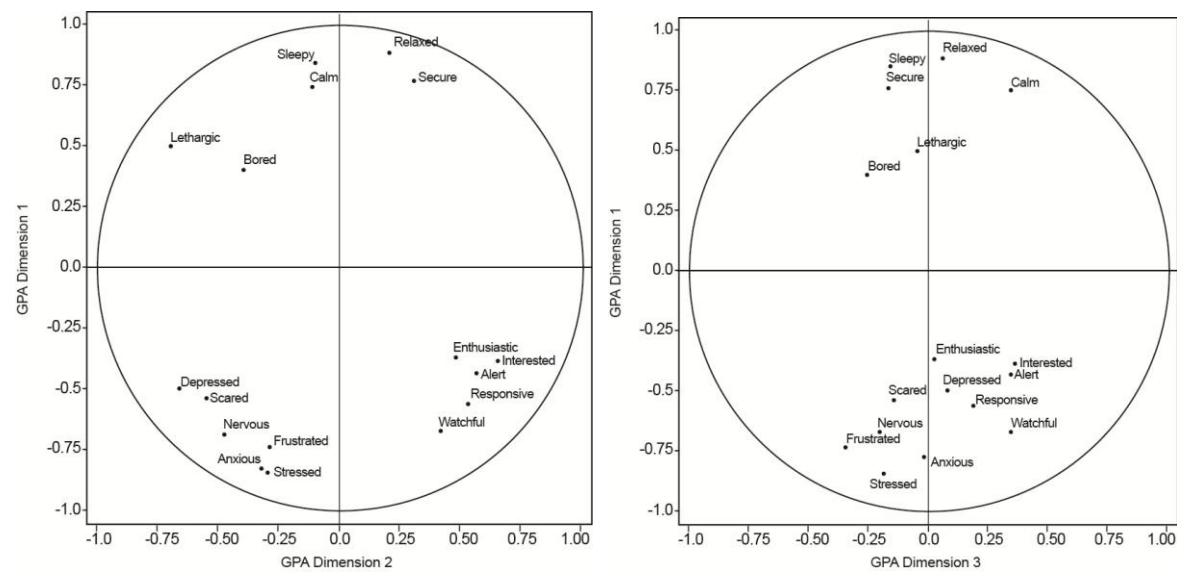


Figure 2

HE Assessment



NE Assessment

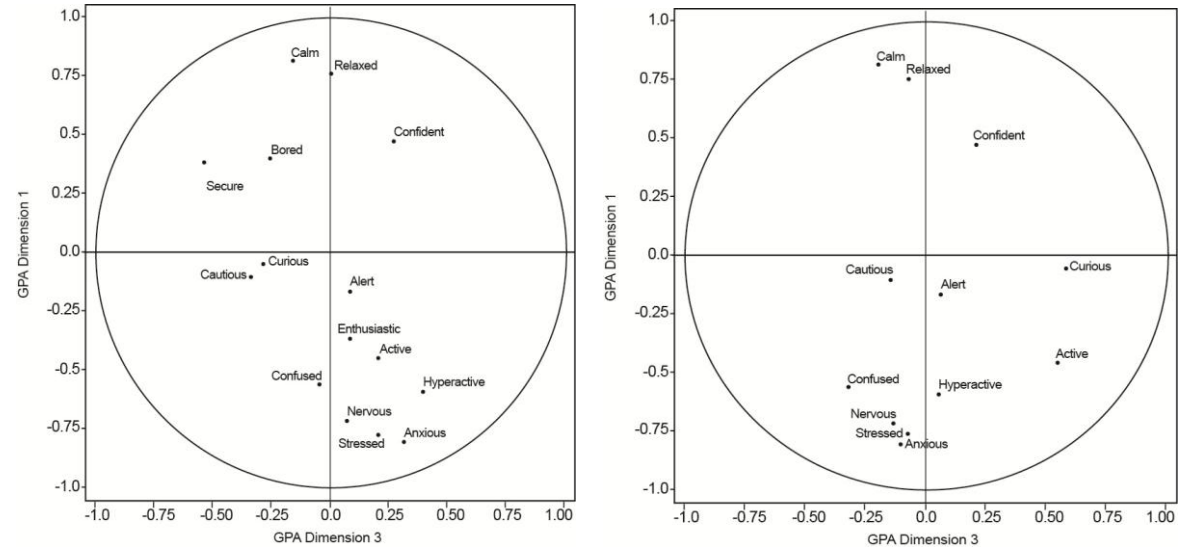
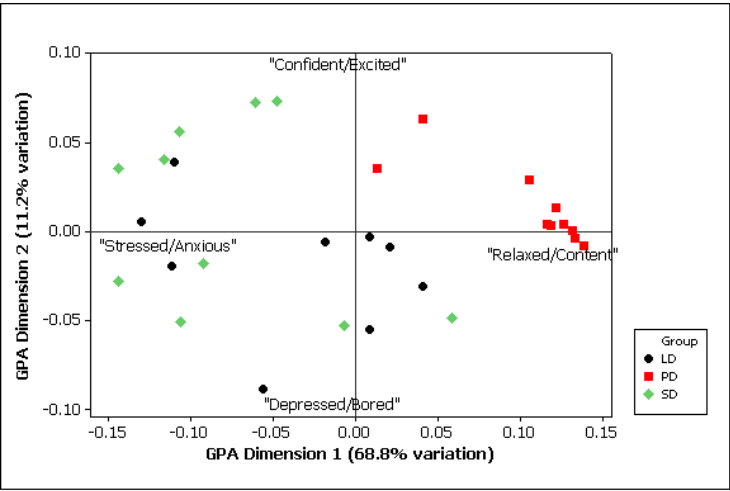
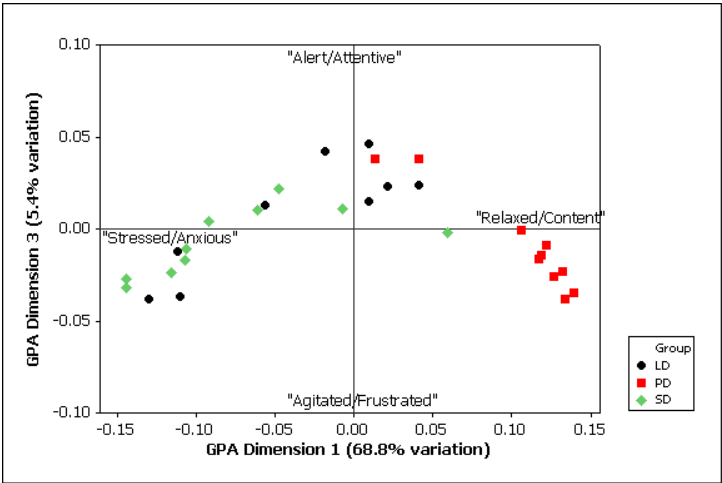


Figure 3

HE Assessments

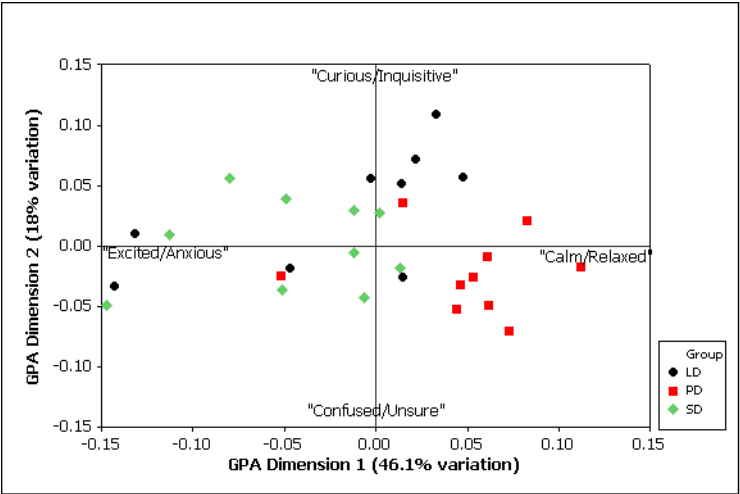


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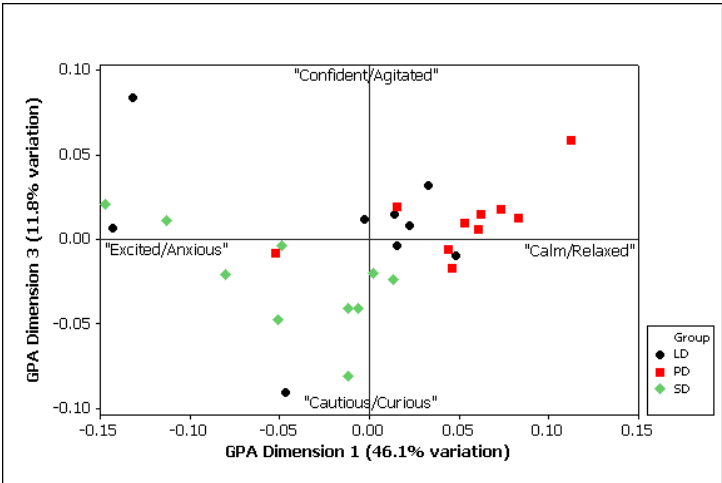


3b:

NE Assessments



3c:



3d: